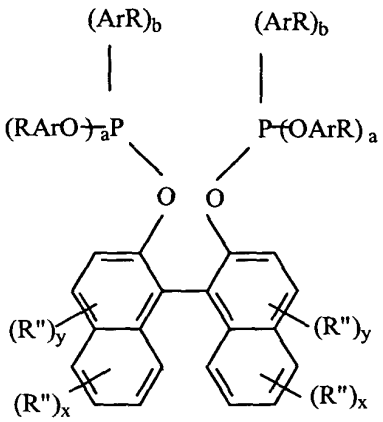
CLAIM(S)

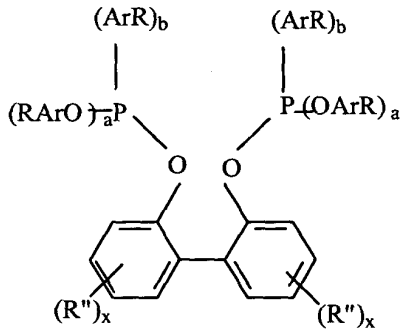
What is claimed is :

1. A phosphorus-containing, bidentate ligand monomer compound of the Formula I or of the Formula II,



I

and



II

wherein:

x = 0 to 4;

y = 0 to 2;

a and b are individually either 0, 1, or 2, provided a+b = 2;

each Ar is individually selected from the group consisting of phenyl, substituted phenyl, naphthyl, and substituted naphthyl, provided that the two Ar groups that are directly or indirectly bonded to the same phosphorus atom may be linked to each other by a linking unit selected from the group consisting of direct bond, alkylidene, secondary or tertiary amine, oxygen, sulfide, sulfone, and sulfoxide;

each Ar can be further substituted with C_1 to C_{20} branched or straight chain alkyl, C_1 to C_{20} cycloalkyl, C_6 to C_{20} aryl, acetal, ketal, alkoxy, cycloalkoxy, aryloxy, formyl, ester, fluorine, chlorine, bromine, perhaloalkyl, hydrocarbylsulfinyl, hydrocarbylsulfonyl, hydrocarbylcarbonyl or cyclic ether;

each R is individually selected from the group consisting of hydrogen, ethenyl, propenyl, acryloyl, methacryloyl and an organic radical with a terminal ethenyl, propenyl, acryloyl, or methacryloyl group;

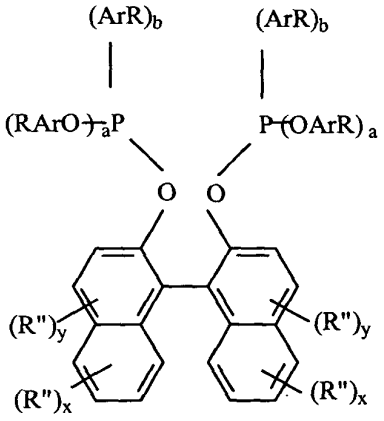
each R" is individually selected from the group consisting of hydrogen, linear or branched alkyl, cycloalkyl, acetal, ketal, aryl, alkoxy, cycloalkoxy, aryloxy, formyl, ester, fluorine, chlorine, bromine,

perhaloalkyl, hydrocarbylsulfinyl, hydrocarbylsulfonyl, hydrocarbylcarbonyl, cyclic ether, ethenyl, propenyl, and an organic radical with a terminal ethenyl or propenyl group;

provided at least one R represents ethenyl, propenyl, acryloyl, methacryloyl or the organic radical with a terminal ethenyl, propenyl, acryloyl, or methacryloyl group or at least one R" represents ethenyl, propenyl, or the organic radical with a terminal ethenyl or propenyl group.

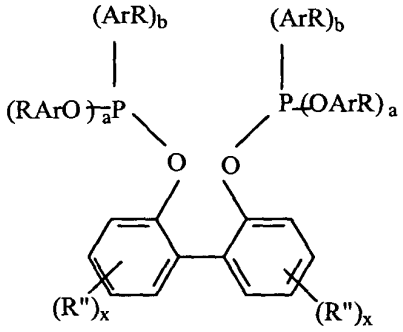
2. A compound of Claim 1, Formula I, wherein a = 2, b = 0, R is primary or secondary alkyl located ortho to the oxygen bonded to Ar, wherein y ≥1, and wherein at least one R" is primary or secondary alkyl group and is located at the ortho position of the oxygen bonded to the binaphthalene group, or a compound of Claim 1, Formula II wherein a = 2, b = 0, R is primary or secondary alkyl located ortho to the oxygen bonded to Ar, wherein x ≥1 and wherein at least one R" is primary or secondary alkyl group and is located at the ortho positions of the oxygen bonded to the biphenylene group.

3. A process for preparing compositions comprising phosphorus-containing, bidentate ligand (monomer) compounds of Formula I, wherein a is 1 or 2 and b is 0 or 1 with the condition that a + b = 2, or compounds of Formula II, wherein a is 1 or 2 and b is 0 or 1 with the condition that a + b = 2,



I

and



II

wherein:

x = 0 to 4;

y = 0 to 2;

each Ar is individually selected from the group consisting of phenyl, substituted phenyl, naphthyl, and substituted naphthyl, provided that the two Ar groups that are directly or indirectly bonded to the same phosphorus atom may be linked to each other by a linking unit selected from the group consisting of direct bond, alkylidene, secondary or tertiary amine, oxygen, sulfide, sulfone, and sulfoxide;

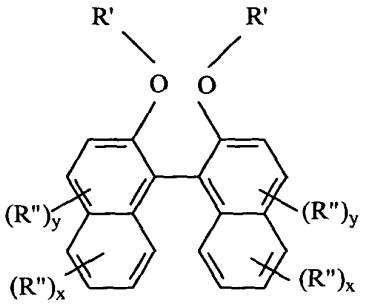
each R" is individually selected from the group consisting of hydrogen, linear or branched alkyl, cycloalkyl, acetal, ketal, aryl, alkoxy, cycloalkoxy, aryloxy, formyl, ester, fluorine, chlorine, bromine, perhaloalkyl, hydrocarbylsulfinyl, hydrocarbylsulfonyl, hydrocarbylcarbonyl, cyclic ether, ethenyl, propenyl, and an organic radical with a terminal ethenyl or propenyl;

each R is individually selected from the group consisting of hydrogen, acryloyl, methacryloyl and an organic radical with a terminal acryloyl, or methacryloyl group; provided at least one R is acryloyl or methacryloyl or an organic radical with a terminal acryloyl or methacryloyl group, said process comprising:

(1) reacting at least one of acryloyl chloride or methacryloyl chloride with a polyhydric alcohol to make at least one of monoacrylate or monomethacrylate,

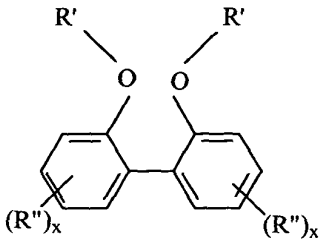
(2) reacting at least one of monoacrylate or monomethacrylate with at least one of phosphorus trichloride or phosphorodichloridite or aryldichlorophosphine (Cl_2P-Ar) to give at least one phosphorochloridite- or aryl,aryloxychlorophosphinite-containing acrylate or methacrylate,

(3) reacting at least one phosphorochloridite- or aryl,aryloxychlorophosphinite- containing acrylate and/or methacrylate from step (2) with at least one compound of Formula III and/or at least one compound of Formula IV,



III

and



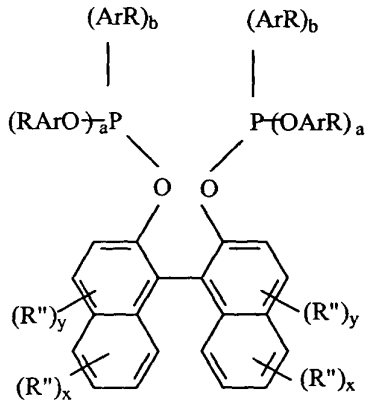
IV

wherein:

each R' individually is hydrogen or M, wherein M is an alkali metal or an alkaline earth metal.

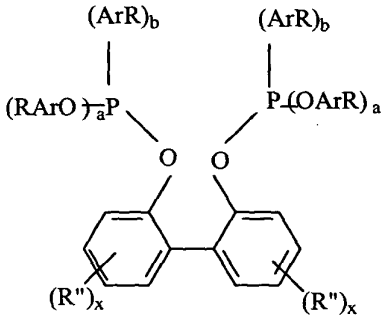
4. A compound of Claim 3, Formula III, wherein a = 2, b = 0, R is primary or secondary alkyl located ortho to the oxygen bonded to Ar, wherein y ≥1, and wherein at least one R" is primary or secondary alkyl group and is located at the ortho position of the oxygen bonded to the binaphthalene group, or a compound of Claim 2, Formula IVwherein a = 2, b = 0, R is primary or secondary alkyl located ortho to the oxygen bonded to Ar, wherein x ≥1 and wherein at least one R" is primary or secondary alkyl group and is located at the ortho positions of the oxygen bonded to the biphenylene group.

5. A method for making a polymeric, phosphorus-containing composition by heating, in the presence of an initiator, and, optionally in the presence of a Group VIII transition metal, a composition comprising at least one compound of Formula I and/or at least one compound of Formula II,



I

and



II

wherein:

x = 0 to 4;

y = 0 to 2;

a and b are individually either 0, 1, or 2, provided a+b = 2;

each Ar is individually selected from the group consisting of phenyl, substituted phenyl, naphthyl, and substituted naphthyl, provided that the two Ar groups that are directly or indirectly bonded to the same

phosphorus atom may be linked to each other by a linking unit selected from the group consisting of direct bond, alkylidene, secondary or tertiary amine, oxygen, sulfide, sulfone, and sulfoxide;

each Ar can be further substituted with C_1 to C_{20} branched or straight chain alkyl, C_1 to C_{20} cycloalkyl, C_6 to C_{20} aryl, acetal, ketal, alkoxy, cycloalkoxy, aryloxy, formyl, ester, fluorine, chlorine, bromine, perhaloalkyl, hydrocarbylsulfinyl, hydrocarbylsulfonyl, hydrocarbylcarbonyl or cyclic ether;

each R is individually selected from the group consisting of hydrogen, ethenyl, propenyl, acryloyl, methacryloyl and an organic radical with a terminal ethenyl, propenyl, acryloyl, or methacryloyl group;

each R" is individually selected from the group consisting of hydrogen, linear or branched alkyl, cycloalkyl, acetal, ketal, aryl, alkoxy, cycloalkoxy, aryloxy, formyl, ester, fluorine, chlorine, bromine, perhaloalkyl, hydrocarbylsulfinyl, hydrocarbylsulfonyl, hydrocarbylcarbonyl, cyclic ether, ethenyl, propenyl, and an organic radical with a terminal ethenyl or propenyl group;

provided at least one R represents ethenyl, propenyl, acryloyl, methacryloyl or the organic radical with a terminal ethenyl, propenyl, acryloyl, or methacryloyl group or at least one R" represents ethenyl, propenyl, or the organic radical with a terminal ethenyl or propenyl group,

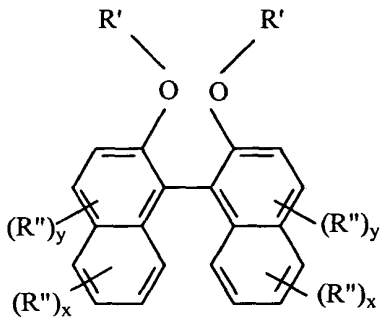
at atmospheric pressure and a temperature between 20°C and 150°C for 1 to 100 hours to produce the polymeric composition.

6. A compound of Claim 5, Formula I, wherein a = 2, b = 0, R is primary or secondary alkyl located ortho to the oxygen bonded to Ar, wherein $y \geq 1$, and wherein at least one R" is primary or secondary alkyl group and is located at the ortho position of the oxygen bonded to the binaphthalene group, or a compound of Claim 5, Formula II wherein a = 2, b = 0, R is primary or secondary alkyl located ortho to the oxygen bonded to Ar, wherein $x \geq 1$ and wherein at least one R" is primary or secondary alkyl group and is located at the ortho positions of the oxygen bonded to the biphenylene group.

7. The method of claim 5 wherein the initiator is a free radical initiator.

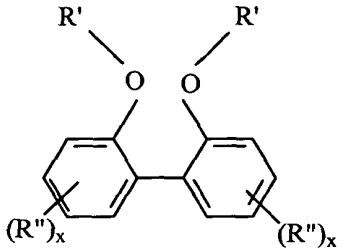
8. A polymeric, phosphorus-containing composition made by the process of Claim 5.

9. A method for making a polymeric composition by heating, in the presence of an initiator, a composition comprising at least one compound of Formula III or at least one compound of Formula IV:



III

and



IV

wherein:

x = 0 to 4;

y = 0 to 2;

each R' is individually selected from the group consisting of hydrogen or an alkali metal or an alkaline earth metal or a hydroxyl protective group selected from the group consisting of alkyl, alkoxyalkyl, carbonylalkyl, and a crown ether formed by taking both R' groups together;

each R" is individually selected from the group consisting of hydrogen, linear or branched alkyl, cycloalkyl, acetal, ketal, aryl, alkoxy, cycloalkoxy, aryloxy, formyl, ester, fluorine, chlorine, bromine, perhaloalkyl, hydrocarbylsulfinyl, hydrocarbylsulfonyl, hydrocarboylcarbonyl, cyclic ether, ethenyl, propenyl, and an organic radical with a terminal ethenyl or propenyl group; provided at least one R" is ethenyl, propenyl, or the organic radical with a terminal ethenyl or propenyl group.

10. A compound of Claim 9, Formula I, wherein a = 2, b = 0, R is primary or secondary alkyl located ortho to the oxygen bonded to Ar, wherein y ≥1 and wherein at least one R" is primary or secondary alkyl group and is located at the ortho position of the oxygen bonded to the binaphthalene group, or a compound of Claim 1, Formula II wherein a = 2, b = 0, R is primary or secondary alkyl located ortho to the oxygen bonded to Ar, wherein x ≥1 and wherein at least one R" is primary or secondary

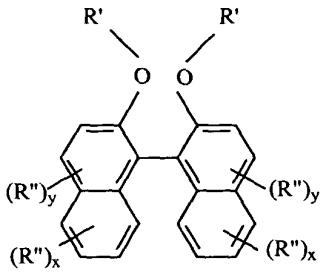
alkyl group and is located at the ortho positions of the oxygen bonded to the biphenylene group.

11. The method of claim 9 wherein the initiator is a free radical initiator.

12. A polymeric composition made by the method of Claim 9.

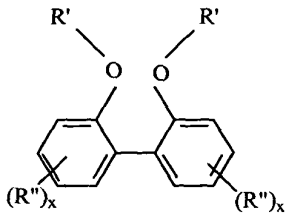
13. A process for making a polymeric, phosphorus-containing composition by:

(1) heating, in the presence of an initiator, a composition comprising at least one compound of Formula III and/or at least one compound of Formula IV:



III

and



IV

wherein:

x = 0 to 4;

y = 0 to 2;

each R' is individually selected from the group consisting of hydrogen or an alkali metal or an alkaline earth metal or a hydroxyl protective group selected from the group consisting of alkyl, alkoxyalkyl, carbonylalkyl, and a crown ether formed by taking both R' groups together;

each R" is individually selected from the group consisting of hydrogen, linear or branched alkyl, cycloalkyl, acetal, ketal, aryl, alkoxy, cycloalkoxy, aryloxy, formyl, ester, fluorine, chlorine, bromine, perhaloalkyl, hydrocarbylsulfinyl, hydrocarbylsulfonyl, hydrocarboylcarbonyl, cyclic ether, ethenyl, propenyl, and an organic radical with a terminal ethenyl or propenyl group; provided at least one R" is ethenyl, propenyl, or the organic radical with a terminal ethenyl or propenyl group and

(2) if R' is a hydroxyl protective group, converting R' to H or an alkali metal or alkaline earth metal and,

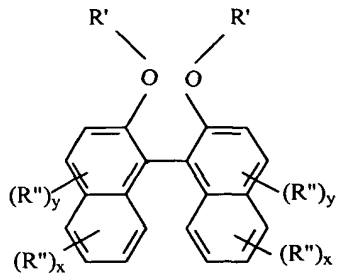
(3) phosphonylating the product of step (1) if R' is other than a hydroxyl protective group, or the product of steps (1) and (2) if R' is a hydroxyl protective group, with trivalent phosphorus of a diaryloxyphosphite unit, -P(-O-Ar)$_2$, a diarylphosphine unit, -P(Ar)$_2$, or an aryl,aryloxyphosphinite unit, -P(Ar)(-O-Ar), or mixture thereof, where each Ar is individually selected from the group consisting of phenyl, substituted phenyl, naphthyl, and substituted naphthyl, provided that the two Ar groups that are directly or indirectly bonded to the same phosphorus atom may be linked to each other by a linking unit selected from the group consisting of direct bond, alkylidene, secondary or tertiary amine, oxygen, sulfide, sulfone, and sulfoxide.

14. A compound of Claim 13, wherein the trivalent phosphorus is a diaryloxyphosphite unit, -P(-O-Ar)$_2$, and the compound of Formula III, wherein a = 2, b = 0, the Ar group contains a primary or secondary alkyl located ortho to the oxygen bonded to Ar, wherein y ≥1 and wherein at least one R" is primary or secondary alkyl group and is located at the ortho position of the oxygen bonded to the binaphthalene group, or a compound of Claim 13, Formula IV wherein a = 2, b = 0, the Ar group contains a primary or secondary alkyl located ortho to the oxygen bonded to Ar, wherein x ≥1 and wherein at least one R" is primary or secondary alkyl group and is located at the ortho positions of the oxygen bonded to the biphenylene group.

15. The method of claim 13 wherein the initiator is a free radical initiator.

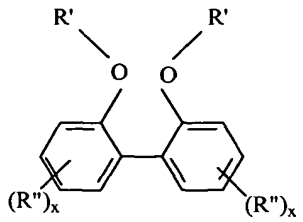
16. A polymeric composition made by the method of Claim 13.

17. A method to produce a polymeric, phosphorus-containing composition by heating a phosphorochloridite containing at least one acrylate or methyl acrylate group in the presence of an initiator to produce a polymer containing phosphorochloridite, and further reacting this polymer with a composition comprising at least one compound of Formula III and/or Formula IV:



III

and



IV

wherein:

x = 0 to 4;

y = 0 to 2;

each R' is individually selected from the group consisting of hydrogen or an alkali metal or an alkaline earth metal or a hydroxyl protective group selected from the group consisting of alkyl, alkoxyalkyl, carbonylalkyl, and a crown ether formed by taking both R' groups together, with the provision that if R' is protected, the protecting group must be removed before reacting the compound of Formula III and/or Formula IV with the polymer containing phosphorochloridite;

each R" is individually selected from the group consisting of hydrogen, linear or branched alkyl, cycloalkyl, acetal, ketal, aryl, alkoxy, cycloalkoxy, aryloxy, formyl, ester, fluorine, chlorine, bromine, perhaloalkyl, hydrocarbylsulfinyl, hydrocarbylsulfonyl, hydrocarboylcarbonyl, cyclic ether, ethenyl, propenyl, and an organic radical with a terminal ethenyl or propenyl group; provided at least one R" is ethenyl, propenyl, or the organic radical with a terminal ethenyl or propenyl group.

18. A compound of Claim 17, Formula III, wherein a = 2, b = 0, R is primary or secondary alkyl located ortho to the oxygen bonded to Ar, wherein y ≥1, and wherein at least one R" is primary or secondary alkyl group and is located at the ortho position of the oxygen bonded to the binaphthalene group, or a compound of Claim 17, Formula IV, wherein a = 2, b = 0, R is primary or secondary alkyl located ortho to the oxygen bonded to Ar, wherein x ≥1 and wherein at least one R" is primary or secondary alkyl group and is located at the ortho positions of the oxygen bonded to the biphenylene group.

19. The method of Claim 17 where the initiator is a free radical initiator.

20. A polymeric composition made by the method of Claim 17.

21. A catalyst composition comprising
(1) at least one monomeric, phosphorus-containing composition of Claim 1 and at least one Group VIII metal, or
(2) at least one polymeric, phosphorus-containing composition of Claim 8, and at least one Group VIII metal, or
(3) at least one polymeric, phosphorus-containing composition of Claim 12, Claim 16, or Claim 20 and at least one Group VIII metal.

22. The catalyst composition of Claim 21 wherein the Group VIII metal is nickel, palladium, or cobalt.

23. The catalyst composition of Claim 21 wherein the Group VIII metal is rhodium, iridium or platinum.

24. The catalyst composition of Claim 21 wherein the Group VIII metal is nickel.

25. The catalyst composition of Claim 22 or 24 further comprising a Lewis acid.

26. The catalyst composition of Claim 25 wherein the Lewis acid is selected from the group consisting of $ZnBr_2$, ZnI_2, $ZnCl_2$, $ZnSO_4$, $CuCl_2$, CuCl, $Cu(O_3SCF_3)_2$, $CoCl_2$, CoI_2, FeI_2, $FeCl_3$, $FeCl_2$, $FeCl_2(THF)_2$, $TiCl_4(THF)_2$, $TiCl_2$, $ClTi(OiPr)_2$, $MnCl_2$, $ScCl_3$, $AlCl_3$, $(C_8H_{17})AlCl_2$, $(C_8H_{17})_2AlCl$, (iso-$C_4H_9)_2AlCl$, Ph_2AlCl, $PhAlCl_2$, $ReCl_5$, $ZrCl_4$, $NbCl_5$, VCl_3, $CrCl_2$, $MoCl_5$, YCl_3, $CdCl_2$, $LaCl_3$, $Er(O_3SCF_3)_3$, $Yb(O_2CCF_3)_3$, $SmCl_3$, $B(C_6H_5)_3$, $(C_6H_5)_3SnX$, where $X=CF_3SO_3$, $CH_3C_6H_5SO_3$, or $(C_6H_5)_3BCN$ and $TaCl_5$.

27. The catalyst composition of Claim 26 wherein the Lewis acid is zinc chloride or iron chloride.

28. A hydroformylation process comprising contacting an unsaturated organic compound with CO and H_2 in the presence of a catalyst composition comprising

(1) at least one monomeric, phosphorus-containing composition of Claim 1 and at least one Group VIII metal, or

(2) at least one polymeric, phosphorus-containing composition of Claim 8, and at least one Group VIII metal, or

(3) at least one polymeric, phosphorus-containing composition of Claim 12, Claim 16, or Claim 20 and at least one Group VIII metal.

29. The hydroformylation process of Claim 28 wherein the Group VIII metal is rhodium, iridium or platinum.

30. The hydroformylation process of Claim 29 wherein the unsaturated organic compound is selected from the group consisting of 3-pentenenitrile, 3-pentenoic acid, 3-pentenal, allyl alcohol, and alkyl 3-pentenoate or mixture thereof.

31. The hydroformylation process of Claim 30 wherein the unsaturated organic compound contains less than 100 ppm peroxides and the Group VIII metal is rhodium.

32. A hydrocyanation process comprising contacting an unsaturated organic compound with HCN in the presence of a catalyst composition comprising

(1) at least one monomeric, phosphorus-containing composition of Claim 1 and at least one Group VIII metal, or

(2) at least one polymeric, phosphorus-containing composition of Claim 8, and at least one Group VIII metal, or

(3) at least one polymeric, phosphorus-containing composition of Claim 12, Claim 16, or Claim 20 and at least one Group VIII metal, and optionally a Lewis acid.

33. The hydrocyanation process of Claim 32 wherein the Lewis acid is selected from the group consisting of $ZnBr_2$, ZnI_2, $ZnCl_2$, $ZnSO_4$, $CuCl_2$, CuCl, $Cu(O_3SCF_3)_2$, $CoCl_2$, CoI_2, FeI_2, $FeCl_3$, $FeCl_2$, $FeCl_2(THF)_2$, $TiCl_4(THF)_2$, $TiCl_2$, $ClTi(OiPr)_2$, $MnCl_2$, $ScCl_3$, $AlCl_3$, $(C_8H_{17})AlCl_2$,

$(C_8H_{17})_2AlCl$, (iso-$C_4H_9)_2AlCl$, Ph_2AlCl, $PhAlCl_2$, $ReCl_5$, $ZrCl_4$, $NbCl_5$, VCl_3, $CrCl_2$, $MoCl_5$, YCl_3, $CdCl_2$, $LaCl_3$, $Er(O_3SCF_3)_3$, $Yb(O_2CCF_3)_3$, $SmCl_3$, $B(C_6H_5)_3$, and $TaCl_5$.

34. The hydrocyanation process of Claim 33 wherein the Lewis acid is zinc chloride or iron chloride.

35. The hydrocyanation process of Claim 34 wherein the Group VIII metal is nickel, palladium or cobalt.

36. The hydrocyanation process of Claim 35 wherein the Group VIII metal is nickel.

37. The hydrocyanation process of Claim 36 wherein the unsaturated organic compound is 3-pentenenitrile or 4-pentenenitrile or mixture thereof.

38. The hydrocyanation process of Claim 37 wherein the HCN contains less than 20 ppm sulfur dioxide, less than 40 ppm sulfuric acid, less than 20 ppm cyanogen, less than 10 ppm epoxide, less than 20 ppm acrylonitrile, and less than 100 ppm peroxides, and the pentenenitriles contain less than 100 ppm peroxides.

39. The hydrocyanation process of Claim 32 wherein the Group VIII metal is nickel, palladium or cobalt and the unsaturated organic compound is 1,3-butadiene.

40. The hydrocyanation process of Claim 39 wherein the Group VIII metal is nickel.

41. The hydrocyanation process of Claim 40 wherein the HCN contains less than 20 ppm sulfur dioxide, less than 40 ppm sulfuric acid, less than 20 ppm cyanogen, less than 10 ppm epoxide, less than 20 ppm acrylonitrile, and less than 100 ppm peroxides, and the 1,3-butadiene contains less than 5 ppm *t*-butyl catechol, less than 500 ppm vinylcyclohexene, and less than 100 ppm peroxides.

42. An isomerization process comprising reacting an unsaturated organic nitrile compound in the presence of a catalyst composition comprising

(1) at least one monomeric, phosphorus-containing composition of Claim 1 and at least one Group VIII metal, or

(2) at least one polymeric, phosphorus-containing composition of Claim 8, and at least one Group VIII metal, or

(3) at least one polymeric, phosphorus-containing composition of Claim 12, Claim 16, or Claim 20 and at least one Group VIII metal.

43. The isomerization process of Claim 42 wherein the Group VIII metal is nickel, palladium or cobalt.

44. The isomerization process of Claim 43 wherein the unsaturated organic nitrile compound is 2-methyl-3-butenenitrile and the Group VIII metal is nickel.

45. The isomerization process of Claim 44 wherein the 2-methyl-3-butenenitrile contains less than 100 ppm peroxides.